

Erosion Prevention BMPs

Use erosion prevention measures during and after construction site preparation in order to safely convey clean water to storm drains or adequate watercourses. One or more measures should be utilized as appropriate during the project's construction phase. Such measures may include but are not limited to: phasing and construction sequencing, surface roughening, temporary seeding, mulching, erosion control blankets, and reinforcement matting. Each of these measures is discussed in the Sections below.

In addition to site-specific erosion control measures, the grading plan includes the following general measures as a minimum:

- Vegetated finished cut and fill slopes should not be steeper than 3H:1V, unless an erosion control blanket or turf reinforcement mat is used.
- Do not place cuts or fills close to property, endangering adjoining property without adequately protecting such properties against erosion, sedimentation, slippage, settlement, subsidence, or other damages.
- Provide subsurface drainage in areas having a high water table to intercept seepage that affects slope stability, bearing strength, and undesirable wetness.
- Do not place fill material where it can slide or wash onto another property.
- Do not place fill adjacent to channel banks where it can create bank failure, reduce the capacity of the stream, or result in downstream sediment deposition.
- Include all borrow and disposal areas as part of the grading plan.

Erosion Prevention Measures

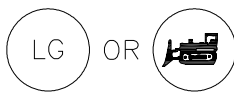
- Provide adequate channels and floodways to safely convey increased runoff from the developed area to an adequate outlet without causing significant channel degradation, or increased off-site flooding.
- Grade the site to direct flows to appropriate controls.

The following Erosion Prevention Measures are discussed in this handbook:

- Surface Roughening
- Temporary Seeding
- Mulching
- Erosion Control Blankets (ECBs)
- Turf Reinforcement Mats (TRMs)
- Flexible Growth Matrix (FGM)
- Bonded Fiber Matrix (BFM)
- Permanent Seeding
- Sodding
- Riprap
- Outlet Protection
- Dust Control
- Polyacrylamide (PAM)

Surface Roughening

Plan Symbol



Description

Surface roughening is the creation of horizontal grooves, depressions, or steps that run parallel to the contour of the land. The following surface roughening measures are approved for use:

- Tracking (driving a crawler tractor up and down a slope, leaving the cleat imprints parallel to the slope contour).
- Stair-step grading.
- Grooving (using disks, spring harrows, or teeth on the bucket of a front-end loader).

Tracking

Description

Tracking is defined as driving tracked machinery up and down slopes, leaving the cleat imprints parallel to the slope contour.

When and Where to Use It

To slow erosion, perform tracking as soon as possible after the vegetation has been removed from the slope. Use tracking with temporary seeding and temporary mulching to stabilize an area. Perform tracking immediately after grading activities have ceased (temporarily or permanently) in an area.

Installation

Avoid excessive compacting of the soil surface when tracking since soil compaction inhibits vegetation growth and causes higher runoff rates. As few passes as possible should be made with the machinery in order to minimize compaction.

Seed and mulch surface roughened areas by the means of tracking within 14 days.

Stair-Step Grading

Description

Stair-Step Grading is defined as cutting stair-steps into slopes with each step having a maximum horizontal distance of 4-feet and a maximum vertical distance of 4-feet.

When and Where to Use It

To slow erosion, perform stair step grading within 7 days after the removal of vegetation from the slope. Stair step grading is applicable on cut slopes with a gradient steeper than 3H:1V but less than 2H:1V. Stair-step grading is applicable on any material soft enough to be moved with a bulldozer. Stair-step grading works well with soils containing large amounts of small rock. Prepare stairs wide enough to work with standard earth moving equipment. Stair-step grading is used with seeding to stabilize an area.

Installation

The ratio of vertical cut distance to horizontal distance is steeper than 1V:1H and the horizontal portion of the “step” slopes towards the vertical wall.

Seed and stabilize areas graded in this manner within 14 days.

Grooving

Description

Slope Grooving is defined as using machinery to create a series of ridges and depressions that run perpendicular to the slope on the contour.

When and Where to Use It

To slow erosion, perform slope grooving within 7 days after the removal of vegetation from the slope.

Groove cut and fill slopes with a gradient steeper than 3H:1V but less than 2H:1V. Grooving is done by any implement that is safely operated on the slope.

Slope Grooving is used with seeding and planting to stabilize an area.

Installation

Install slope grooving with any appropriate implement that is safely operated on the slope not causing undue compaction. Suggested implements include discs, chisel plows, and the teeth on a front-end loader bucket. Install grooves a minimum of three inches deep and no further than 15 inches apart.

Seed and stabilize areas that are graded in this manner within 14 days.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, re-grade and re-seed immediately.



Surface Roughening (Tracking)

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Rills appear.	Re-grade and re-seed area immediately.

Temporary Seeding

Plan Symbol



Description

The purpose of temporary seeding is to reduce erosion and sedimentation by stabilizing disturbed areas that would otherwise lay bare for long periods of time before they are worked or stabilized. Temporary seeding is also used where permanent vegetation growth is not necessary or appropriate.

When and Where to Use It

Temporary seeding is used on exposed soil surfaces such as denuded areas, soil stockpiles, dikes, dams, banks of sediment basins, banks of sediment traps, and temporary road banks. Temporary seeding prevents and limits costly maintenance operations on other sediment control structures. Sediment clean-out requirements for sediment basins, sediment traps, and silt fence is reduced if the drainage area is seeded when grading and construction operation are not taking place.

Temporary stabilization is required within 14 days after construction activity is complete **unless construction activity is going to resume within 21 days**. Cover seeded areas with an appropriate mulch to provide protection from the weather. When the temporary vegetation does not grow quickly or thick enough to prevent erosion, re-seed as soon as possible. Keep seeded areas adequately moist. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Seed Selection

Seed selection is based on geographical location, soil type and the season of the year in which the planting is to be done. Use the tables in Appendix C as a guide for conventional tillage methods (plowing, seedbed preparation, hydroseeding, etc). If a fast growing crop to nurse the permanent specie or species is required, then use the mix rate. Failure to carefully follow agronomic recommendations results in an inadequate stand of temporary vegetation that provides little or no erosion control.

Installation **Tillage**

If the area has been recently plowed, no tillage is required other than raking or surface roughening to break any crust that has formed leaving a textured surface. Disk the soil for optimal germination when the soil is compacted less than 6-inches.

Soil Testing

Soil testing is available through Clemson University Cooperative Extension Service.

Lime

Lime is not required for temporary seeding unless a soil test shows that the soil pH is below 5.0. It may be desirable to apply lime during the temporary seeding operation to benefit the long-term permanent seeding. Apply a minimum of 1.5 tons of Lime/acre (70 lbs./1000 ft²) when used.

Fertilizer

Apply a minimum of 500 pounds per acre of 10-10-10 fertilizer (11.5 pounds per 1000 square feet) or equivalent during temporary seeding unless a soil test indicates a different requirement. Incorporate fertilizer and lime (if used) into the top 4-6 inches of the soil by disking or other means where conditions allow.

Seeding

Loosen the soil surface before broadcasting the seed. Apply seed evenly by the most convenient method available for the type of seed used and the location of the temporary seeding. Typical application methods include but are not limited to cyclone seeders, rotary spreaders, drop spreaders, broadcast spreaders, hand spreaders, cultipacker seeder, and hydro-seeders. Cover applied seed by raking or dragging a chain, and then lightly firm the area with a roller or cultipacker.

Mulching

Use mulch with temporary seed applications to retain soil moisture and reduce erosion during the establishment of vegetation. Typical mulch applications include straw, wood fiber, hydromulches, BFM and FGM. Use hydromulches with a minimum blend of 70% wood fibers.

The most commonly accepted mulch used in conjunction with temporary seeding is small grain straw. This straw should be dry and free from mold damage and noxious weeds. The straw may need to be anchored with netting or emulsions to prevent it from being blown or washed away. Apply the straw mulch by hand or machine at the rate 1.5-2 tons per acre (90 pounds per 1000 square feet). Frequent inspections are necessary to check that conditions for growth are good.

Irrigation

Seeded areas should be kept adequately moist. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Re-seeding

Re-seed areas where seeding does not grow quickly, thick enough, or adequately to prevent erosion. Base seed selection should on the requirements of local Specifications.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Cover seeded with mulch to provide protection. Frequent inspections are necessary to check that conditions for growth are good.
- Supply temporary seeding with adequate moisture. Supply water as needed, especially in abnormally hot or dry weather or on adverse sites. Control water application rates to prevent runoff.
- Base seed selection on local Specifications.
- Re-seed areas where the plants do not grow quick enough, thick enough, or adequately enough to prevent erosion should be re-seeded.



Temporary Slope Stabilization

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope was improperly dressed before application.	Roughen slopes. Furrow along the contour of areas to be seeded.
Coverage is inadequate.	Follow recommended application rates. Count the number of seedbags to ensure the correct amount of material is being applied. Reapply to thin areas.
Seeds fail to germinate.	Apply straw mulch to keep seeds in place and to moderate soil moisture and temperature. In arid areas, temporary irrigation may be necessary.
Seeded slope fails.	Fill in rills and re-seed; fertilize and mulch slopes.
Seeding is washed off slope.	Allow at least 24-hours for the materials to dry before a rain event. Follow manufacturer's recommendations. Reapply where necessary.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area and to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Mulching

Plan Symbol



Description

Mulching is a temporary soil stabilization erosion control method where materials such as grass, hay, wood chips, wood fibers, or straw are placed on the soil surface. In addition to stabilizing soils, mulching can enhance the absorption of water by the soil, reduce evaporation losses, regulate soil temperatures and reduce the speed of storm water runoff over an area.

When and Where to Use It

Use erosion control mulching on level areas or on slopes up to 50 percent. Where soil is highly erodible, nets should only be used in connection with organic mulch such as straw and wood fiber.

Mulch is an effective ground cover when the establishment of vegetation is improbable due to severe weather conditions (winter conditions), poor soil, or steep slopes.

Installation

Grading is not necessary before mulching but may be required if vegetation is expected to grow.

Anchor loose hay or straw by applying tackifier, stapling netting over the top, or crimping with a mulch-crimping tool.

Effective use of netting and matting material requires firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material.

Materials that are heavy enough to stay in place (for example, bark or wood chips on flat slopes) do not need anchoring.

Apply hydro-mulch in spring, summer, or fall to prevent deterioration of mulch before vegetation becomes established.

There must be adequate coverage to prevent erosion, washout, and poor plant establishment. If an appropriate tacking agent is not applied, or is applied in insufficient amounts, mulch is lost to wind and runoff.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Repair or replace damaged areas of mulch or tie-down material immediately.



Straw Mulching



Straw Mulch

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Mulch blows away.	Anchor straw mulch in place by applying a tackifier, crimping, punching, or track walking. May need to use a different BMP.
Coverage is inadequate.	Follow recommended application rates. Ensure that the correct amount of material is implemented. Reapply as necessary.
Mulch is washed away.	Do not place mulch in concentrated flow areas. Reapply as necessary.
Area was improperly dressed before application.	Remove existing vegetation and roughen embankment and fill areas by rolling with a punch type roller or by track walking.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow onto stabilized area and/or to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Erosion Control Blankets (ECBs)

Plan Symbol



Description

Temporary erosion control blankets (ECBs) are products composed primarily of biologically, photochemically or otherwise degradable constituents such as wheat straw, coconut fiber, or aged curled excelsior wood product with longevity of approximately 1- to 3-years.

When and Where to Use It

Use ECBs for temporary stabilization of soil immediately following seeding until the vegetative cover has grown and becomes established. ECBs provide temporary protection by degrading over time as the vegetation becomes established. Some products are effective for a few months while others degrade slowly and are effective for up to 3-years.

ECB Categories

- Class A (Slope Applications Only)
- Class B (Channel Applications Only).

Class A ECBs are for slope applications only.

- Applicable for slopes 2H:1V or flatter only. Slopes greater than 2H:1V require Turf Reinforcement Matting (TRM).

Class B ECBs are for channel applications.

- Use for channels and concentrated flow areas with a maximum calculated shear stress less than 1.75 lb/ft². Design shear stresses greater than 1.75 lb/ft² require TRM applications.

All acceptable Class A and Class B temporary erosion control blankets consisting of straw, coconut, or straw-coconut blends meet the following requirements:

- Use non-organic, photodegradable or biodegradable polypropylene netting.
- Consist of **double netted matting**, defined as matting with netting on both sides of the blanket. The top netting is degradable polypropylene with a maximum mesh opening of 0.75 inches by 0.75 inches. The bottom is degradable polypropylene with a maximum mesh opening of 0.5 inches by 0.5 inches.
- Be sewn on center a maximum of 2.0 inches

All acceptable Class A and Class B temporary erosion control blankets consisting of curled excelsior fibers meet the following requirements:

- Use non-organic, photodegradable or biodegradable polypropylene netting
- Consist of **double netted matting**. Double netted matting is matting with netting on both sides of the blanket. The degradable polypropylene top netting requires a maximum mesh opening of 1.0-inches by 1.0-inches. The degradable polypropylene bottom netting requires a maximum mesh opening of 1.0-inches by 1.0-inches
- Consist of curled excelsior interlocking fibers with 80% of the fibers a minimum of 6-inches long
- Sewn on center a maximum of 4.0-inches.

Use Class A and Class B temporary erosion control blankets having the following Minimum Average Roll Values (MARV) for physical properties, as derived from quality control testing performed by a Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) accredited laboratory:

- Minimum mass per unit area (ASTM D6475) of 6 oz/yd² (203 g/m²)
- Minimum thickness (ASTM D6525) of 0.25-inches (6 mm)
- Minimum initial grab tensile strength (ASTM D6818) of 75x75 lb/ft. (1x1 kN/m)
- Minimum roll width of 48-inches (1.22 m)

- For Class B channel applications, a minimum unvegetated shear stress of 1.0 lb/ft² (48 N/m²) based on short-term peak flow duration of 0.5 hour is required.

Installation

Grade and compact ECB protected areas as indicated on the plans.

Remove large rocks, soil clods, vegetation, and other sharp objects that could keep the ECB from intimate contact with subgrade.

Prepare seedbed by loosening 2 to 3 inches of soil above final grade.

Proper ECB installation is different for each product, therefore follow the recommended installation procedure from the specific manufacturer.

When requested, a Manufacturer's Representative may be required to be on-site to oversee and approve the initial installation of the ECB. When requested, a letter from the Manufacturer approving the contractor installation may be required.

Inspection and Maintenance

- Inspect areas protected by ECBs for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Conduct regular inspections until grasses are firmly established.
- Adhere to the pinning or stapling pattern as shown on the Manufacturer's installation sheet.
- If there is evidence that the ECB is not securely fastened to the soil, require extra pins or staples to inhibit the ECB from becoming dislodged.
- If washout or breakage occurs, repair all damaged areas immediately by restoring the soil on slopes or channels to its finished grade, re-apply fertilizer and seed, and replacing the appropriate ECB material as needed.



ECB Slope Applications

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Undercutting occurs along the top of the slope.	Dig a 6-x 6-inch trench along the top of the slope and anchor blanket into trench by back filling and tamping the soil.
Blankets separate along the seams.	Overlap adjacent blanket 2- to 3-inch and staple every 3-feet.
Blankets separate where the rolls are attached end to end.	Shingle the blanket so the top blanket covers the bottom blanket by 6-inches and staple through the overlapped areas every 12-inches.
Blanket does not make complete contact with the soil surface.	Prepare the soil surface by removing rocks, clods, sticks and vegetation, fill in rill and uneven areas.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Turf Reinforcement Mats (TRMs)

Plan Symbol



Description

Turf Reinforcement Mats are products composed primarily of nondegradable products that enhance the ability of living plants to stabilize soils. They bind with roots to reinforce the soil matrix with longevity greater than 5-years.

When and Where to Use It

Use TRMs where vegetation alone will not hold a slope or streambank. TRMs enable the use of “green” solutions in areas where only “hard” solutions such as riprap or concrete linings were viable in the past.

TRM Categories

- Type 1, Type 2, Type 3 and Type 4.

Types 1 & 2 TRMs are a strong three-dimensional stable net structure. A degradable fiber matrix may be included to provide immediate coverage for bare soil.

- **Type 1** matting should be placed on slopes **2H:1V or flatter** or in channels where the calculated design shear stress is **4.0 lb/ft² or less** and the design flow velocity is **up to 10 fps**.
- **Type 2** matting should be placed on slopes **1.5H:1V or flatter** or in channels where the calculated design shear stress is **6.0 lb/ft² or less** and the design flow velocity is **up to 15 fps**.

- **Type 3** TRMs are a strong three-dimensional stable net structure providing sufficient thickness, strength, and void space to capture and retain soil and allow for the development of root growth and vegetation within the matrix. Matting of this type should be placed on slopes **1H:1V or flatter** or in channels where the calculated design shear stress is **8.0 lb/ft² or less** and the design flow velocity is **up to 20 fps**.
- **Type 4** (High Survivability) TRMs are specially designed geosynthetics for erosion control applications on steep slopes and vegetated waterways.
- All components of Type 4 TRMs should be 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.
- Matting of this type should be placed on slopes **1H:1V or greater** or in channels where the calculated design shear stress is **up to 12 lb/ft²** and the design flow velocity is **up to 25 fps**.
- This category is used when field conditions exist with high loading and/or high survivability requirements such as maintenance, structural backfills protecting critical structures, utility cuts, potential traffic areas, abrasion, higher factors of safety and/or general durability concerns.

All primary TRM matrix materials are defined as long-term, non-degradable materials designed to reduce soil erosion and assist in the growth, establishment, and protection of vegetation for a period of time exceeding 5 years.

The major structural components of Type 1 and Type 2 TRMs are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. A degradable fiber matrix may be included to provide immediate coverage for bare soil. All components of Type 3 and Type 4 TRMs are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

Installation

Grade and compact areas to be protected with TRMs as indicated on the plans.

Remove large rocks, soil clods, vegetation, and other sharp objects that could keep the TRM from intimate contact with subgrade.

Prepare seedbed by loosening 2 to 3 inches of soil above final grade.

The proper installation of TRMs is different for each product, therefore the recommended installation procedure from the specific manufacturer should be followed.

When requested, a Manufacturer's Representative may be required to be on-site to oversee and approve the initial installation of the TRM. When requested, a letter from the Manufacturer approving the contractor installation may be required.

Inspection and Maintenance

- Check areas protected by TRMs for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Conduct regular inspections until grasses are firmly established.
- Adhere to the pinning or stapling pattern as shown on the Manufacturer's installation sheet. If there is evidence that the TRM is not securely fastened to the soil, require extra pins or staples to inhibit the TRM from becoming dislodged.
- If washout or breakage occurs, repair all damaged areas immediately by restoring the soil on slopes or channels to its finished grade, re-apply fertilizer and seed, and replacing the appropriate TRM material as needed.



TRM Slope Application



TRM Channel Application

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Improper anchoring.	Dig trench along the top and bury the blankets. Use staples to anchor according to manufacturer's recommendations.
Undercutting due to inadequate preparation.	Prepare the soil surface. Remove rocks, clods and other obstructions. Fill in rills in uneven areas to promote good contact between mat and soil.
Excessive water flows across stabilized slope surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Flexible Growth Media/Matrix

Plan Symbol



Description

A Flexible Growth Matrix (FGM) combines both chemical and mechanical bonding techniques to lock the matrix in place. FGM is composed of crimped, manmade fibers, organic fibers, and performance-enhancing additives that form a lofty, interlocking matrix. FGM has air spaces and water-absorbing cavities that improve seed germination, reduce the impact of raindrop energy, and minimize soil loss. Water insoluble tackifiers and flocculants chemically bond the matrix to the soil surface.

When and Where to Use It

FGM is applicable for the following situations:

- As a Type A Temporary Erosion Control Blanket
- Slopes up to 2H:1V
- As an infill for TRMs on slopes greater than 2H:1V
- Environmentally sensitive areas not compatible for netting
- When the required longevity of soil protection is up to 1 year
- When the site requires immediate erosion protection and there is a risk of impending weather
- When fast vegetation establishment is required
- When a high factor of design safety is required.

FGM is **not** applicable as a channel liner or for areas receiving concentrated flow. Applicable FGM may be selected from the SCDOT approved products list.

Installation

All FGM components are pre-packaged by the Manufacturer to assure material performance. Under no circumstances is field mixing of materials, additives or components accepted. Examine substrates and conditions where materials will be applied. Apply FGM to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope. Do not proceed with installation until satisfactory conditions are established.

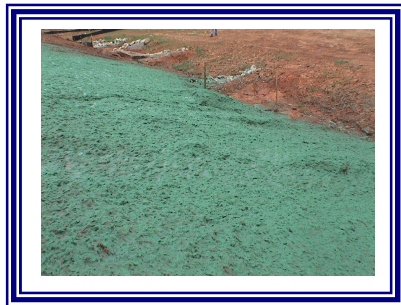
Install FGM with a contractor who is certified and trained by the Manufacturer in the proper procedures for mixing and applying the FGM. Strictly comply with the Manufacturer's mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzle (50-degree tip) for FGM applications. Apply FGM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. FGM does not require a cure time and is effective immediately such that FGM may be applied immediately before, during or after a rainfall event. Install FGM materials according to the Manufacturer's application rates.

Inspection and Maintenance

- Check areas protected by FGM for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Reapply FGM to disturbed areas that require continued erosion control.
- Maintain equipment to provide uniform application rates. Rinse all mixing and application equipment thoroughly with water to avoid formation of residues and discharge rinse water appropriately.
- Degradation of FGM is expected to occur as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt, and temperature. Reapply FGM in accordance with the Manufacturer's instructions. Reapplication is not required unless FGM treated soils are disturbed or turbidity or water quality shows the need for an additional application.



FGM Application



FGM

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope areas have eroded due to concentrated flows.	<p>Make sure the upper end of the slope has a berm constructed to eliminate concentrated flows from flowing down the slope.</p> <p>Slope length may be too long and concentrated flows are occurring. Use sediment tubes or other practices to provide slope breaks.</p> <p>Re-apply FGM to the eroded areas once the concentration problem has been resolved.</p>
Rain event is impending.	FGM does not require a cure time and is effective immediately such that FGM may be applied immediately before, during or after a rainfall event.
FGM has degraded.	FGM has longevity of soil protection up to 1 year. Reapply FGM in accordance with the Manufacturer instructions. Reapplication is not required unless FGM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

Bonded Fiber Matrix (BFM)

Plan Symbol



Description

A Bonded Fiber Matrix (BFM) is a continuous layer of non-toxic, degradable, elongated fiber materials held together by water insoluble bonding agents. BFM eliminates direct raindrop impact on soil, allows no gaps between the product and the soil, and has a high water-holding capacity. BFM's do not form a water-insensitive crust that can inhibit plant growth. BFM's are completely photo- and biodegradable.

When and Where to Use It

BFM's are applicable when:

- Enhancement of temporary seeding operations to reduce erosion and expedite seed germination
- A high performance mulch is required for permanent seeding
- Seeding application will take place on highly erodible soil or slopes
- Slopes up to 1H:1V
- The required functional longevity of soil protection is 6 months or less
- The soil is dry and rain is not expected within 48 hours after application
- There is a high degree of certainty that heavy rains will not follow application.

BFM's are **not** applicable as Type A Temporary Erosion Control Blankets, channel liners or for areas receiving concentrated flow. Applicable BFM may be selected from the SCDHEC approved products list.

Installation

All BFM components are pre-packaged by the Manufacturer to assure material performance. Under no circumstances is field mixing of materials, additives or components accepted. Examine substrates and conditions where materials will be applied. Do not proceed with installation until unsatisfactory conditions are corrected. Apply BFM to geotechnically stable slopes that have been designed and built to divert runoff water away from the face of the slope.

Install BFM with a contractor who is certified and trained by the Manufacturer in the proper procedures for mixing and applying the BFM. Strictly comply with the Manufacturer's mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzle (50-degree tip) for BFM applications. Apply BFM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. Do not apply the BFM immediately before, during or after rainfall. Allow the BFM a minimum of 24 hours to dry after installation. Do not exceed maximum slope length of 100 feet when slope gradients are steeper than 4H:1V. Install BFMs at a general application rate of 3500 pounds per acre.

Inspection and Maintenance

- Check areas protected by BFM for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Reapply BFM to disturbed areas that require continued erosion control.
- Maintain equipment to provide uniform application rates. Rinse all BFM mixing and application equipment thoroughly with water to avoid formation of residues and discharge rinse water appropriately.
- Degradation of BFM is expected to occur as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt, and temperature.

- Reapply BFM in accordance with the Manufacturer's instructions when treated soils are disturbed or turbidity or water quality shows the need for an additional application



BFM Application

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope areas have eroded due to concentrated flows.	<ul style="list-style-type: none"> • Make sure the upper end of the slope has a berm constructed to eliminate concentrated flows from flowing down the slope. • Slope length may be too long and concentrated flows are occurring. Use sediment tubes or other practices to provide slope breaks. • Re-apply BFM to the eroded areas once the concentration problem has been resolved.
Rain event is impending.	BFM requires a cure time. Do not apply the BFM immediately before, during or after rainfall. Allow the BFM a minimum of 24 hours to dry after installation.
BFM has degraded.	BFM has longevity of soil protection up to 6-months. Reapply BFM in accordance with the Manufacturer instructions. Reapplication is not required unless BFM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

Permanent Seeding

Plan Symbol



Description

Controlling runoff and preventing erosion by establishing a perennial vegetative cover with seed.

When and Where to Use It

A major consideration in the selection of the type of permanent grass to establish is the intended use of the land. Land use is separated in to two categories, high-maintenance and low-maintenance.

High-maintenance

High maintenance areas are mowed frequently, lime or fertilized on a regular basis, and require maintenance to an aesthetic standard. Land uses with high maintenance grasses include homes, industrial parks, schools, churches, and recreational areas such as parks, athletic fields, and golf courses.

Low-maintenance

Low maintenance areas are mowed infrequently, if at all, and lime and fertilizer may not be applied on a regular schedule. These areas are not subject to intense use and do not require a uniform appearance. The vegetation must be able to survive with little maintenance over long periods of time. Grass and legume mixtures are favored in these areas because legumes are capable of fixing nitrogen in the soil for their own use and the use of the grasses around them. Land uses requiring low-maintenance grasses include steep slopes, stream and channel banks, road banks, and commercial and industrial areas with limited access.

Seed Selection

The use of native species is preferred when selecting vegetation. Base plant seed selection on geographical location, the type of soil, the season of the year in which the planting is to be done, and the needs and desires of the permanent land user. Failure to carefully follow agronomic recommendations results in an inadequate stand of permanent vegetation that provides little or no erosion control.

Installation

Topsoil

Apply topsoil if the surface soil of the seedbed is not adequate for plant growth.

Tillage

If the area has been recently plowed, no tillage is required other than raking or surface roughening to break any crust that has formed leaving a textured surface. Disk the soil for optimal germination when the soil is compacted less than 6-inches. If the soil is compacted more than 6-inches, sub-soiled and disk the area.

Soil Testing

Soil testing is available through Clemson University Cooperative Extension Service.

Lime

Unless a specific soil test indicates otherwise, apply 1½ tons of ground course textured agricultural limestone per acre (70 lbs./1000 ft²).

Fertilizer

Apply a minimum of 1000 pounds per acre of a complete 10-10-10 fertilizer (23 pounds per 1000 square feet) or equivalent during permanent seeding of grasses unless a soil test indicates a different requirement. Incorporate fertilizer and lime (if used) into the top 4-6 inches of the soil by disking or other means where conditions allow. Do not mix the lime and the fertilizer prior to the field application.

Seeding

Loosen the surface of the soil just before broadcasting the seed. Evenly apply seed by the most convenient method available for the type of seed applied and the location of the seeding. Typical application methods include but are not limited to cyclone seeders, rotary spreaders, drop spreaders, broadcast spreaders, hand spreaders, cultipacker seeder, and hydro-seeders. Cover applied seed by raking or dragging a chain or brush mat, and then lightly firm the area with a roller or cultipacker. Do not roll seed that is applied with a hydro-seeder and hydro-mulch.

Mulching

Cover all permanent seeded areas with mulch immediately upon completion of the seeding application to retain soil moisture and reduce erosion during establishment of vegetation. Apply the mulch evenly in such a manner that it provides a minimum of 75% coverage. Typical mulch applications include straw, wood fiber, hydromulches, BFM and FGM. Use hydromulches with a minimum blend of 70% wood fibers.

The most commonly accepted mulch used in conjunction with permanent seeding is small grain straw. Select straw that is dry and free from mold damage and noxious weeds. The straw may need to be anchored with netting or asphalt emulsions to prevent it from being blown or washed away. Apply straw mulch by hand or machine at the rate 2 tons per acre (90 pounds per 1000 square feet). Frequent inspections are necessary to check that conditions for growth are good.

Irrigation

Keep permanent seeded areas adequately moist, especially late in the specific growing season. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Re-seeding

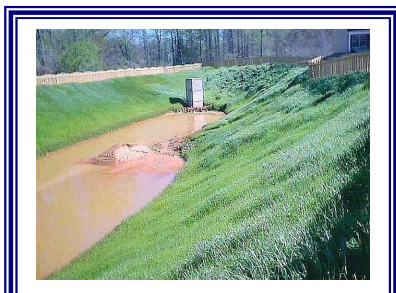
Inspect permanently seeded areas for failure, make necessary repairs and re-seed or overseed within the same growing season if possible. If the grass cover is sparse or patchy, re-evaluate the choice of grass and quantities of lime and fertilizer applied. Final stabilization by permanent seeding of the site requires that it be covered by a 70% coverage rate.

Inspection and Maintenance

- Inspect seeded areas for failure and make necessary repairs and re-seed immediately. Conduct a follow-up survey after one year and replace failed plants where necessary.
- If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.
- If a stand of permanent vegetation has less than 40 percent cover, re-evaluate choice of plant materials and quantities of lime and fertilizer.
- Re-establish the stand following seed bed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results.
- If the season prevents re-sowing, mulch is an effective temporary cover.
- Final stabilization of the site requires a 70 percent overall coverage rate. This does not mean that 30 percent of the site can remain bare. The coverage is defined as looking at a square yard of coverage, in which 70 percent of that square yard is covered with vegetation.



Permanent Seeding



Permanent Seeding

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Areas have eroded.	Reseed or replace eroded areas.
Vegetation cover is inadequate and rill erosion is occurring.	Overseed and fertilize in accordance with soil test results.
Stand of permanent vegetation has less than 40% cover.	Re-evaluate choice of plant materials and quantities of lime and fertilizer.
Vegetation show signs of wilting before noon.	Water vegetation by wetting soil to a depth of 4-inches.

Sodding**Plan Symbol****Description**

Sodding is transplanting vegetative sections of plant materials to promptly stabilize areas that are subject to erosion. Use commercial sod which is a cultured product utilizing specific grass species.

When and Where to Use It

Sodding is appropriate for any graded or cleared area that may erode, and where a permanent, long-lived plant cover is immediately needed. Examples of where sodding is used are yards, buffer zones, streambanks, dikes, swales, slopes, outlets, level spreaders, and filter strips.

Installation

In general, do not use sod on slopes greater than 2H:1V or 3H:1V if it is to be mowed. If sod is placed on steep slopes, lay it with staggered joints and/or staple the sod down.

Clear the soil surface of trash, debris, roots, branches and soil clods in excess of 2-inches length or diameter. Rake soil surface to break crust just before laying sod or irrigate soil lightly if the soil is dry. Do not install sod on hot, dry or frozen soil, gravel, compacted clay, or pesticide treated soils.

Harvest, deliver and install sod within a period of 36-hours. Store rolls of sod in shade during installation. Sod should be free of weeds and be of uniform thickness, about 1-inch, and should have a dense root mat for mechanical strength.

Lay strips of sod beginning at the lowest area to be sodded with the longest dimension of the strip perpendicular to the slope, and stagger in a brick-like pattern. Wedge strips securely in place. Square the ends of each strip to provide for a close, tight fit. Match angled ends correctly to prevent voids.

Roll or compact immediately after installation to ensure firm contact with the underlying topsoil.

Irrigate the sod until the soil is wet to a depth of 2-inches, and keep moist until grass takes root.

Inspection and Maintenance

- Watering may be necessary after planting and during periods of intense heat and/or lack of rain (drought). Keep soil moist to a depth of 2-inches until sod is fully rooted.
- Mow to a height of 2 to 3 inches after sod is well-rooted (2-3 weeks). Do not remove more than 1/3 of the shoot in any one mowing.
- Permanent, fine turf areas require yearly applications of fertilizer and lime.
- Inspect the sod frequently after it is first installed, especially after large storm events, until it has established a permanent cover.



Sodding

Field Condition	Common Solutions
Drought	Keep soil moist to a depth of 2-inches until sod is fully rooted

Riprap

Plan Symbol



Description

Riprap is a permanent, erosion-resistant channel lining aggregate consisting of large, loose, angular stone with a filter fabric or granular underlining. The purpose of riprap is to:

- Protect the soil from the erosive force of concentrated runoff
- Slow runoff velocities while enhancing the potential for infiltration

The filter fabric or granular underlining prevents undermining of the riprap layer by the migration of soil particles under seepage forces through the riprap.

When and Where to Use It

The preferred method of slope and channel protection is the use of vegetation. If vegetation can not withstand the design flows, ECBs and TRMs are the preferred and suggested method of protection. When conditions are too severe for vegetation and TRMs, riprap may be used for erosion control and protection. Riprap is used, as appropriate, at storm drain outlets, on channel banks and/or bottoms, drop structures, at the toe of slopes, and in transitions from concrete channels to vegetated channels. Riprap sizes are designed by the diameter or by the weight of the stones. It is often misleading to think of riprap in terms of diameter, since the stones should be angular instead of spherical.

Installation

Place a lining of geotextile filter fabric or granular filter material between the riprap and the underlying soil surface to prevent soil movement into or through the riprap.

Inspection and Maintenance

- Once a riprap installation has been completed, it should require very little maintenance.
- It should, however, be inspected periodically to determine if high flows have caused scour beneath the riprap and filter fabric or dislodged any of the stone.
- Care must be taken to properly control sediment-laden construction runoff that may drain to the point of the new installation. If repairs are needed, they should be performed immediately.



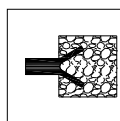
Riprap Lined Channel

Preventive Measures and Troubleshooting Guide

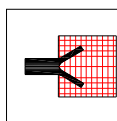
Field Condition	Common Solutions
High flows causing scour beneath riprap or filter fabric dislodging the stone.	Replace filter fabric and rearrange stone appropriately.
Riprap blocks channel, causing erosion along edges.	Make sure excavation is deep enough, rearrange riprap appropriately.
Piping or slumping occurs.	Make sure filter fabric was installed and make sure it isn't damaged.
Stones have moved and erosion of foundation has occurred.	Make sure riprap is properly graded.
Undercut riprap slope and slumping occurring.	Check to be sure that foundation toe is properly reinforced.
Stone displacement occurring.	Make sure fill slopes have been properly compacted, remove debris and make needed repairs.

Outlet Protection

Plan Symbol



RipRap



ECB or TRM

Description

Outlet protection dissipates the energy of concentrated storm water flows reducing erosion or scouring at storm water outlets. In addition, outlet protection lowers the potential for downstream erosion. Outlet protection is achieved through a variety of techniques, including turf reinforcement mats (TRMs), riprap, concrete aprons, paved sections and other structural measures.

The techniques outlined in this section are not the only techniques that may be used for outlet protection design. This section shows one method for outlet protection design as an example of the variables that need to be considered in the design. Other methods utilized that are not discussed in this Handbook should include all graphs, charts, and calculations verifying that the protection will handle the peak flow velocity, flow depths, and shear stress.

Installation

- Do not protect pipe or channel outlets at the top of cut slopes or on slopes steeper than 10% with only outlet protection. This causes re-concentration of the flow resulting in increased velocities when the flow leaves the protection area.
- Follow specific standards for installation of the selected materials used for outlet protection.
- Follow all Manufacturer's installation procedures for TRMs and other manufactured products.

- A Manufacturer's Representative may be required to oversee all installation procedures and officially approve the installation of manufactured products used for outlet protection.

Inspection and Maintenance

- Periodically check all outlet protection, aprons, plunge pools, and structural outlets for damage. Immediately make all needed repairs to prevent further damage.
- If any evidence of erosion or scouring is apparent, modify the design as needed to provide long term protection (keeping in mind fish passage requirements if applicable).
- Inspect outlet structures after heavy rains to see if any erosion has taken place around or below the structure.

The table below provides general information for sizing rock and outlet aprons for various sized pipes.

Culvert Size (inches)	Average Rock Diameter (inches)	Apron Width at the narrow end (feet)	Apron Length for slow flow (feet)	Apron Length for high flow (feet)
8"	3"	2-3 ft	3-5 ft	5-7 ft
12"	5"	3-4 ft	4-6 ft	8-12 ft
18"	8"	4-6 ft	6-8 ft	12-18 ft
24"	10"	6-8 ft	8-12 ft	18-22 ft
30"	12"	8-10 ft	12-14 ft	22-28 ft
36"	14"	10-12 ft	14-16 ft	28-32 ft
42"	16"	12-14 ft	16-18 ft	32-38 ft
48"	20"	14-16 ft	18-25 ft	38-44 ft



Riprap Outlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Riprap washes away.	Replace riprap with a larger diameter based on the pipe diameter and discharge velocity.
Apron is displaced.	Align apron with receiving water and keep it straight throughout its length. Repair damaged fabric and replace riprap that has washed away.
Scour occurs around apron or riprap.	Remove damaged TRM or riprap, fill in scoured areas, and repair damage to slopes channels or underlying filter fabric. Reinstall outlet protection.
Outlet erodes.	Stabilize TRM outlets with vegetation, replace eroded riprap; grout riprap.

Dust Control

Plan Symbol



Description

Wind erosion occurs when the surface soil is loose and dry, vegetation is sparse or absent, the wind is sufficiently strong, and when construction traffic disturbs the soil. Wind erodes soils and transports the sediment off site in the form of fugitive dust, where it may be washed into receiving water bodies by the next rainfall event. Fugitive dust is a nuisance for neighbors. It settles on automobiles, structures and windows and finds its way into homes. It also makes breathing difficult for those with respiratory problems and becomes a safety problem when it blinds motorists, equipment operators, and laborers.

When and Where to Use It

Utilize dust control methods whenever there are offsite impacts, especially during periods of drought. Implemented dust control until final stabilization is reached.

Inspection and Maintenance

- Add additional dust control or re-spray area as necessary to keep dust to a minimum.
- Spray exposed soil areas only with approved dust control agents as indicated by the SCDHEC Standard Specifications.



Dust Control with Water

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive dust leaves the site.	Increase frequency of dust control application. Consider using a palliative or binder on inactive areas.
Vehicles kick up dust.	Water more frequently. Limit vehicle speeds. Stabilize the roadway.
Watering for dust control causes erosion.	Reduce water pressure on the water truck. Check watering equipment to ensure that it has a positive shutoff. Water less frequently.
Sprayed areas are ineffective at limiting dust.	Re-spray areas and ensure that the application rate is proper. Try another product or method if current dust control is not effective.

Polyacrylamides (PAMs)

Plan Symbol



Description

Anionic polyacrylamides (PAM) are non-toxic chemical materials used for controlling soil erosion and sedimentation on construction and agricultural sites.

When and Where to Use It

Anionic PAM is available in emulsions, powders, gel bars, or logs. Use other BMPs in combination with anionic PAM. The use of seed and mulch for additional erosion protection beyond the life of the anionic PAM is required. Repeat application is recommended if disturbance occurs to target areas. The following are additional recommendations:

- Use setbacks when applying anionic PAM near natural waterbodies.
- Consider that decreased performance can occur due to ultra-violet light and time after mixing when applying anionic PAM.
- In concentration channels, the effectiveness of anionic PAM for stabilization decreases.
- If seed is applied with anionic PAM, use mulch to protect seed.
- Never add water to PAM, PAM must be slowly added to water.
- NOT ALL POLYMERS ARE PAM.

Installation

The manufacturer's guidelines for application should be followed.

- Only use the anionic form of PAM. Cationic PAM is toxic and should NOT be used.
- PAM and PAM mixtures have to be environmentally harmless, harmless to fish, wildlife, and plants.
- Use pure form of anionic PAM with less than or equal 0.05 percent acrylamide monomer by weight, established by FDA and EPA.

- To maintain less than or equal 0.05 percent of acrylamide monomer, the maximum application rate of PAM, in pure form, should not exceed 200 pounds/acre/year. Do not over apply.
- Users of anionic PAM should obtain and follow all MSDS requirements and manufacturer's recommendations.
- Additives such as fertilizers, solubility promoters or inhibitors to PAM should be non-toxic.
- To prevent exceeding the acrylamide monomer limit in the event of a spill, the pure form of anionic PAM should not exceed 200 pounds/batch at 0.05 percent acrylamide monomer (AMD) or 400 pounds/batch at 0.025 percent AMD.

Inspection and Maintenance

- PAMs have been estimated to degrade approximately 10 percent per year. The effects are accelerated in highly exposed areas.
- If PAM treated soil is left undisturbed, reapplication may be necessary after 6-8 weeks.
- Further anionic PAM applications may be required for disturbed areas including highly silty and clayey soils, steep slopes, long grades, and high traffic or precipitation areas.
- All equipment should be maintained to provide the application rates recommended by the manufacturer.
- Rinse all equipment used to mix and apply anionic PAM thoroughly with water.



Liquid PAM



Solid/Block PAM

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope was improperly dressed before application.	Roughen slope and fill damaged areas.
Coverage is inadequate.	Follow recommended application rates. Reapply to thin areas.
Sprayed areas degrade or become ineffective.	Follow recommended application rates. Consider other or additional BMPs. Reapply as necessary.
Sprayed slope has spot failures.	Repair slopes, add jute netting and re-spray damaged areas.
Portions of the sprayed area have been disturbed.	Keep workers and equipment off sprayed areas. Repair and re-spray areas that have been damaged.
PAM is washed off slope.	Allow at least 24 hours for the materials to dry before a rain event. Follow manufacturer's recommendations. Reapply as necessary.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize slopes with swift moving concentrated flows.